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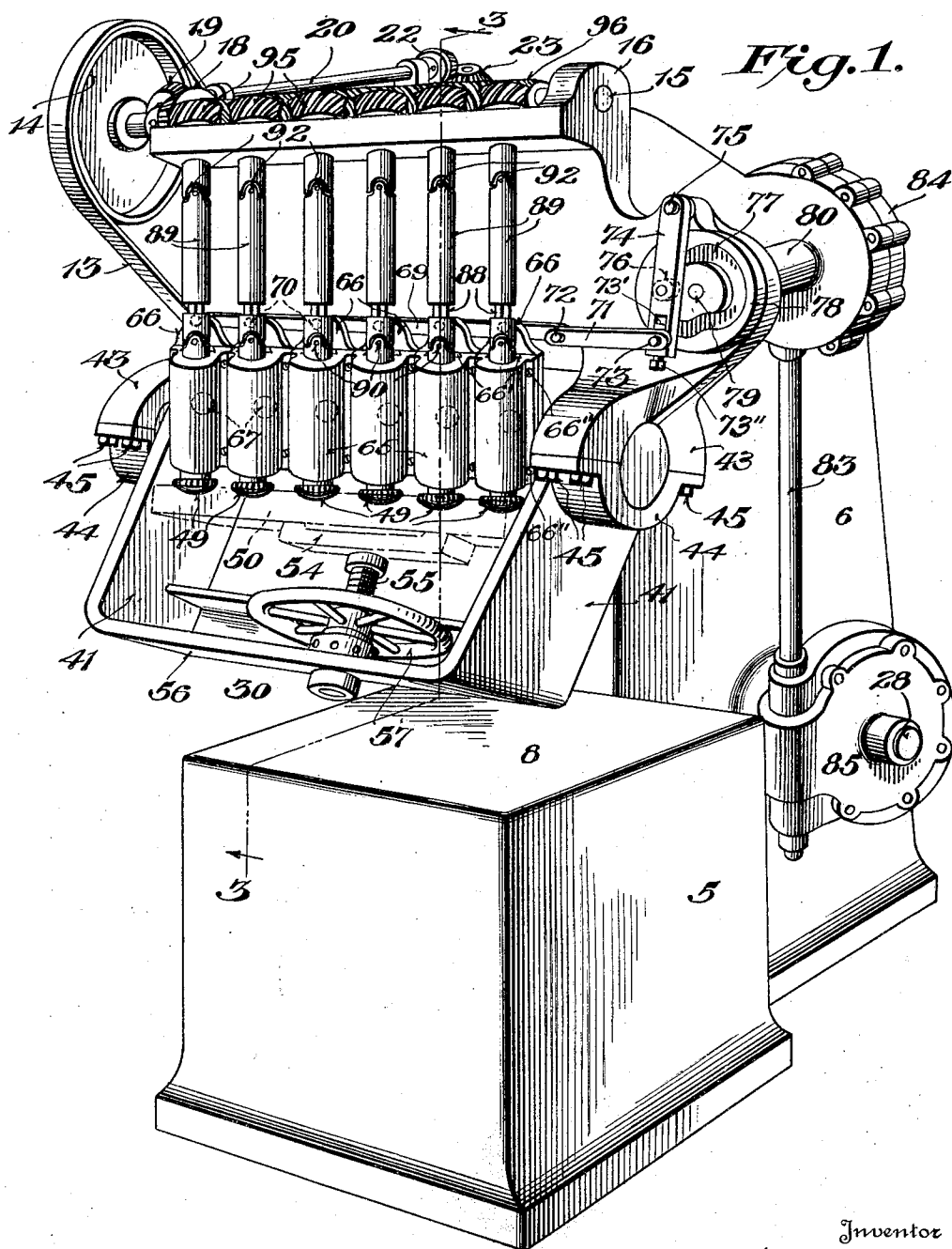
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1,876,204

METAL WORKING MACHINE

Filed April 21, 1927

4 Sheets-Sheet 1



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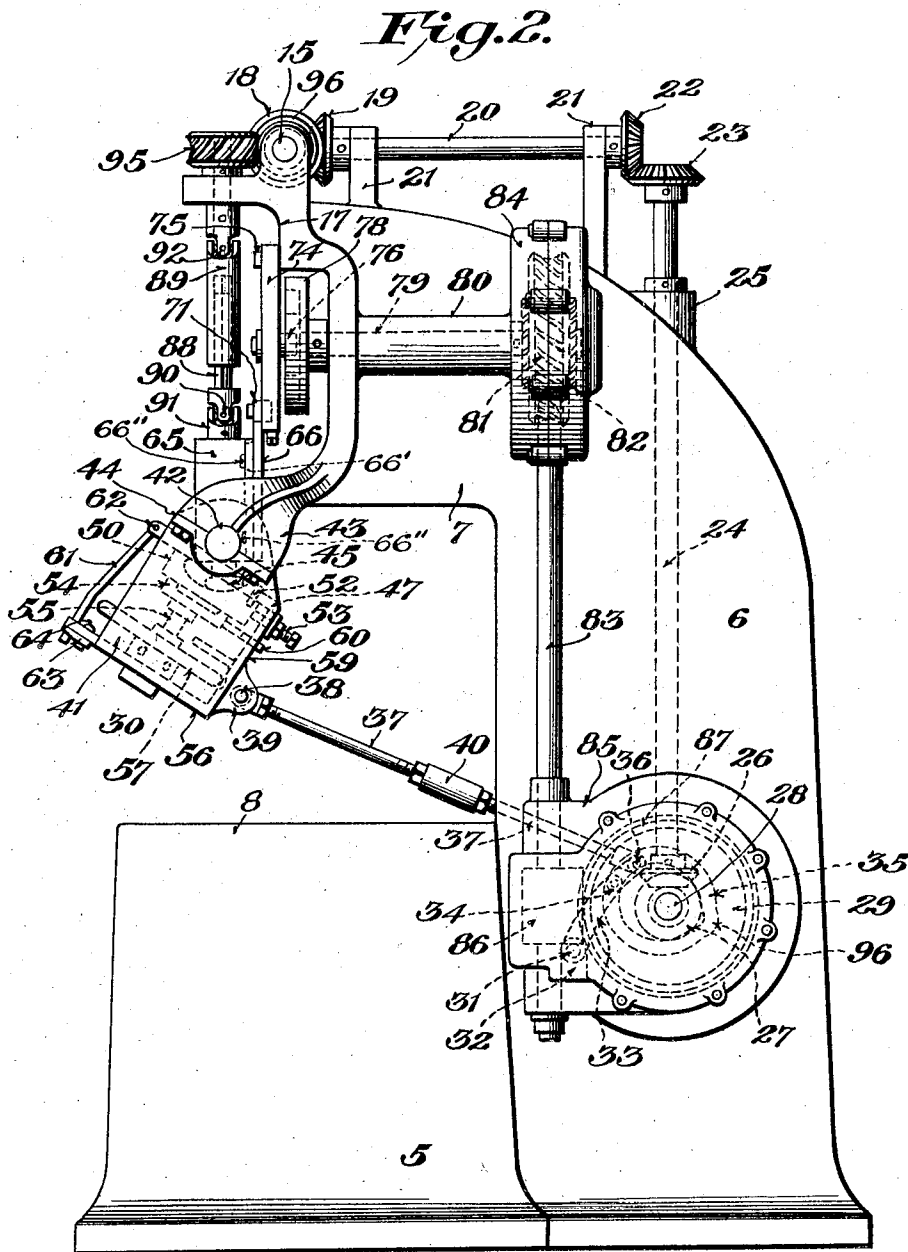
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4 Sheets-Sheet 2



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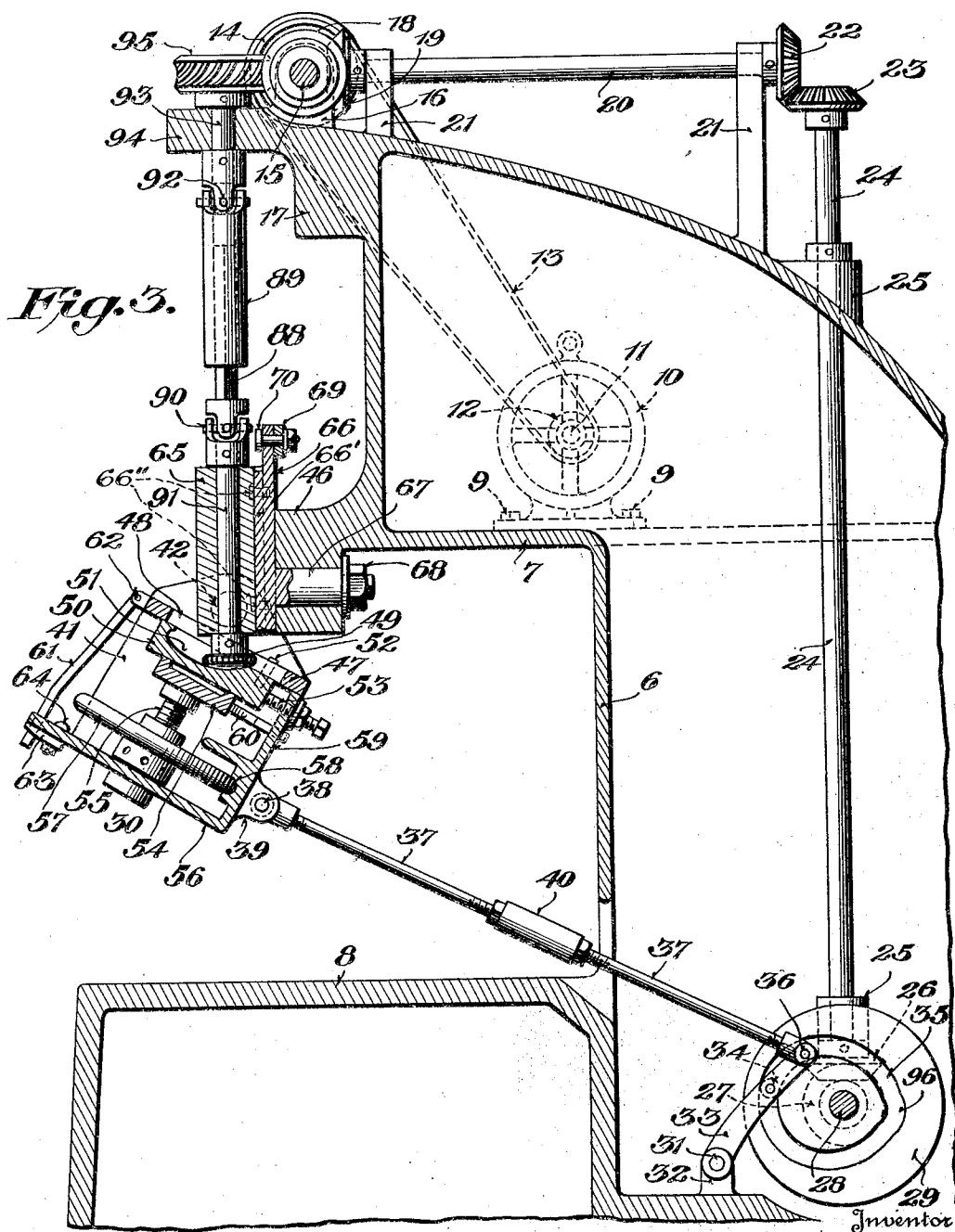
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METAL WORKING MACHINE

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4 Sheets-Sheet 3



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Filed April 21, 1927 4 Sheets-Sheet 4

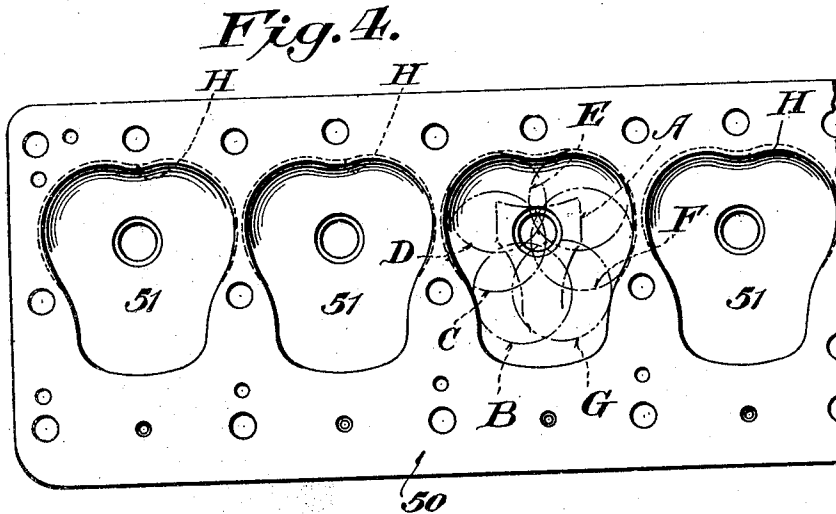


Fig. 5.

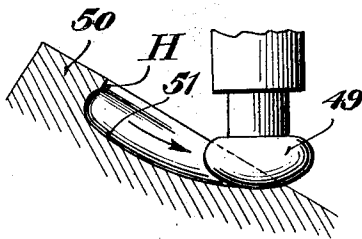


Fig. 6.

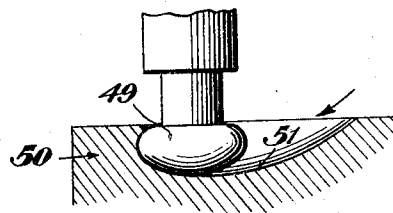
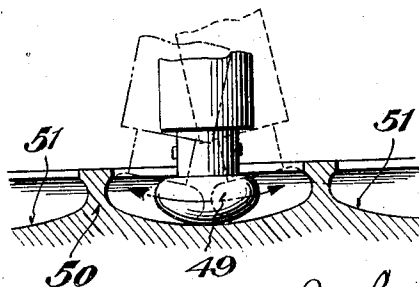


Fig. 7.



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METAL WORKING MACHINE

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This invention relates to metal working machines, and while capable of general use, is particularly adapted for machining or profiling the walls of compression recesses formed in cylinder heads for hydrocarbon motors.

Cylinder heads for hydrocarbon motors have heretofore been cast with compression recesses therein of tapered depth, and it frequently happens that irregularities occur in the contours of the compression recess such as to produce variation in compression of the several cylinders of the hydrocarbon motor with the resulting defective operation of the latter. It has therefore been proposed to machine the walls or surfaces of the tapered compression recesses uniformly to produce uniform compression in the cylinders of the hydrocarbon motor and the principal object of the present invention is to provide an improved mechanism for profiling a compression recess and one which is adapted to profile a tapered compression recess which is undercut at its deeper portion around the valves and has certain recognized advances over tapered compression recesses heretofore employed.

Other objects of this invention are to provide an improved mechanism which embodies a swinging work holder or cradle and swinging mills cooperating therewith to machine the entire surfaces of the tapered compression recesses; which includes an arrangement of swiveled mills or cutters and a swinging cylinder head support that enables the walls of the tapered recesses to be undercut at the deeper portions thereof; which insures a positive and continuous drive for the mills or cutters during their swinging movement, through the medium of flexible driving connections for said cutters with a source of power; and which is a simply constructed, expeditious, and highly efficient mechanism for machining the walls of tapered compression recesses or for profiling various other classes of work.

In order to more clearly understand this invention, reference may be had to the accompanying drawings which illustrate one

embodiment of the inventive idea and wherein:—

Fig. 1 is a detail perspective view of the machine, with parts omitted for purposes of clearer illustration;

Fig. 2 is a side elevation of the machine shown in Fig. 1;

Fig. 3 is a vertical sectional view on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary bottom plan view of a cylinder head, showing diagrammatically the machining and undercutting operations;

Figs. 5 and 6 are sectional details, showing the manner of machining and undercutting the wall of a tapered compression recess in the direction of its length; and

Fig. 7 is a sectional detail, showing the manner of machining and undercutting the wall of the recess laterally thereof.

Referring to the drawings, wherein like reference characters designate like parts throughout the several views, 5 indicates the base of the machine provided at the rear thereof with a vertical column 6. Extending forwardly from the column 6 is a head 7 that overhangs a table 8 at the top of the base 5 (Figs. 1, 2 and 3). The machine may be driven from any desired source of power. As here shown, there is bolted or otherwise suitably secured at 9, 9 on the column 6, an electric motor 10 (Fig. 3) the armature shaft 11 of which has fixed thereon a pulley 12 around which passes a belt 13. This belt also passes around a pulley 14 loosely mounted on one extremity of a driven shaft 15 that is journaled in suitable bearings 16, 16 on a saddle 17 which projects forwardly from the head 7 at the upper end thereof.

The driven shaft 15, as clearly shown in Fig. 1, extends horizontally across the machine to the opposite sides thereof, and constitutes the main source of power for imparting motion to the various movable instrumentalities hereinafter described. Fixed on the driven shaft 15 is a bevel gear 18 that meshes with a similar gear 19 rigidly secured on one end of a shaft 20 disposed substantially at right angles to the shaft 15 and journaled in suitable bearings 21, 21 on the

upper surface of the head 7. The opposite end of the shaft 20 has fixed thereon a bevel gear 22 that meshes with a similar gear 23 rigidly secured on the upper end of a vertical shaft 24 that is journaled in suitable bearings 25, 25 on the column 6 and projects downwardly therein at one side of the machine.

Fixed on the lower end of the shaft 24 is a bevel gear 26 that meshes with a similar gear 27 that is keyed or otherwise rigidly secured on a shaft 28 journaled in suitable bearings in the column 6 and extending therethrough to the opposite sides of the machine. This shaft 28 has fixed thereon a cam 29 which, from the above described driving connections, serves to swing a work support or cradle 30 toward the rear and front of the machine through the medium of the following devices. Pivotaly mounted at 31 on a bracket 32 within the column 6 is an arm 33 provided intermediate its ends with a roller 34 that engages in the groove 35 of cam 29. Pivotaly connected at 36 with the free end of the arm 33 is a rod 37 that is also pivotaly connected at 38 with an ear or lug 39 that projects rearwardly from the cradle 30. The rod 37, as clearly shown in Fig. 3, extends outwardly through a suitable opening in column 6 and is preferably made in two parts connected together by a turnbuckle 40 or other suitable device for adjusting the length of said rod and thereby regulating the amount of swinging movement imparted to the cradle 30 by the cam 29.

The cradle 30 is preferably mounted to swing rearwardly and forwardly of the machine on an axis substantially parallel with that of the driven shaft 15 and for this purpose the side walls 41, 41 of said cradle are provided with trunnions 42, 42 journaled in bearings provided by brackets 43, 43 and bearing blocks 44, 44 bolted or otherwise suitably secured at 45, 45 to the brackets 43, 43 (Fig. 1). The brackets 43, 43 are secured to or formed integrally with a saddle 46 (Fig. 3) that projects forwardly from the head 7 at the lower part thereof, and said brackets, together with the blocks 44, 44, facilitate the mounting of the cradle 30 in or removal of the same from, the bearings provided by the brackets 43, 43 and the blocks 44, 44.

The work holder or cradle 30 has bolted or otherwise suitably secured to the top thereof a frame 47 through an opening 48 of which a plurality of rose end mills or cutters 49, 49 extend to engage with the work to be machined or profiled. As herein disclosed the work consists of a cylinder head 50 that is supported in the cradle 30 in an inverted position against the frame 47 and provided with tapered compression recesses 51, 51, the walls of which are machined and undercut by the mills or cutters 49, 49 in a manner to be hereinafter described. The cylinder head

50 is placed within the cradle through the front thereof which is open for this purpose, said cylinder head preferably being engaged with pins 52 and 53 on the cradle and clamped therein against the frame 47 by a clamping head 54.

The clamping head 54 is rotatably secured on the upper end of a vertical screw shaft 55 threaded through a suitable opening in the bottom 56 of the cradle and adjustable up and down therein through the medium of a hand wheel 57 rotatably mounted on the bottom 56 of the cradle (Fig. 3). The hand wheel 57 is retained against displacement by engagement with a groove 58 formed on the rear wall 59 of the cradle 30. During movement of the shaft 55 and the clamping head 54, rotation of the latter is prevented by a pin 60 that projects rearwardly from said head through a suitable opening formed in the rear wall 59 of said cradle. In order to prevent undue strain on the top and bottom walls of the cradle by the clamping of the work therein, said cradle is provided with a strut bar 61 arranged to extend across the open front of the cradle and pivoted at 62 to the top thereof so that said bar may be swung upwardly out of the way when the work is being placed in the cradle. After the work has been positioned in the cradle, the bar 61 is swung downwardly and secured to the bottom wall 56 of the cradle by a block 63 adjustably mounted on the lower end of the bar 61 and adapted to be connected with the cradle 30 by a pin 64 or other suitable fastening means. After the lower end of the bar has been secured to the bottom of the cradle, the work is clamped in said cradle as above described.

With the parts in the full line positions shown in the drawings, the work is ready for the machining and undercutting operations performed by simultaneously swinging the cradle 30, driving the tools or cutters 49, 49, and swinging the latter on axes extending transversely of the path of swinging movement of the cradle and the cylinder head carried thereby. The mechanism for swinging the cradle has already been described, and the mechanism for driving the cutters and swinging them in the manner stated is preferably constituted by the following instrumentalities. The mills or cutters 49, 49, at the beginning of the machining and undercutting operations, preferably engage the walls or surfaces of the compression recesses 51, 51, at the shallower ends thereof. These mills or cutters are rotatably mounted in tool holders 65, 65 adjustably mounted in any desired manner on swiveled heads or carriers 66, 66 so as to provide for the depth of cut to made in the compression recesses and, if desired, for movement of the mills or cutters into and out of said recesses through the opening 48 in frame 47. As herein shown, the tool holders

65, 65 are adjustable lengthwise of the swiveled heads 66, 66 on guides 66', 66' of the latter, and said holders may be secured in the desired position of adjustment on the heads 66, 66 by set screws 66'', 66'' or other suitable means. The swiveled heads 66, 66 are provided on the rear thereof with trunnions 67, 67 journaled in suitable bearings in the saddle 46 and having their axes extending transversely of the pivotal axis of the cradle 30 and preferably at right angles thereto. The heads 66, 66 swing on a smooth machined surface provided by the front face of the saddle 46, and each trunnion 67 is provided on the end thereof opposite that carrying the head 66 with a retaining nut 68 for preventing displacement of the swiveled head from its bearing in the saddle 46.

The heads 66, 66 with the driven mills or cutters 49, 49 thereon are swung simultaneously by any suitable means such as a rod 69 pivotally connected at 70, 70 with said heads and reciprocated by a link 71 one end of which is pivotally connected at 72 with the rod 69. The opposite end of the link 71 is pivotally connected at 73 with the free end of an arm 74 pivoted at 75 on the overhanging head 7 and carrying a roller 76 that engages in a groove 77 of a cam 78. The connection for the link 71 with the arm 74 is preferably constituted by the pivot 73 that extends through a slot 73' in the arm 74 and is adjusted in said slot by a set screw 73'' to eliminate variation in cutting by the mills or cutters 49, 49, when they wear down or are ground. The cam 78 is fixed on the front end of a shaft 79 journaled in suitable bearings on the head 7 and enclosed in a housing 80 secured thereto. Fixed on the rear end of the shaft 79 is a worm wheel 81 that meshes with a worm 82 rigidly secured on the upper end of a vertical shaft 83 disposed at the side of the machine opposite that carrying the shaft 24. The worm wheel 81, worm 82, and the upper end of the shaft 83, are enclosed in an enlarged portion 84 of the housing 80, the lower end of the shaft 83 projecting into a housing 85 secured to the adjacent side of the column 6 near the bottom thereof. Fixed on the lower end of the shaft 83 is a worm 86 that meshes with a worm wheel 87 keyed or otherwise rigidly secured on the shaft 28 which also extends into the housing 85. It will thus appear that the shaft 28 through the shaft 83, shaft 80, and gearing connecting the same, serves to drive the cam 78 as well as the devices for swinging the cradle 30.

During swinging movement of the heads 66, 66 and the cradle 30, the rose end mills or cutters 49, 49 are driven by means that preferably include flexible connections providing for swinging movement of the heads 66, 66 and cutters 49, 49 as the latter are rotated. As herein shown, these flexible con-

nections are comprised by telescoping shafts, the parts 88, 88 and 89, 89 of which rotate together and slide one within the other as the heads 66, 66 are oscillated. The parts 88, 88 of the telescoping shafts are connected by universal joints 90, 90 with tool spindles 91, 91 that carry the mills or cutters 49, 49 and are journaled in the adjustable tool holders 65, 65. The parts 89, 89 of said telescoping shafts are connected by universal joints 92, 92 with the lower ends of stub shafts 93, 93 that are journaled in suitable bearings in a forwardly extending part 94 of the saddle 17. Fixed on the upper end of the stub shafts 93, 93 are worm wheels 95, 95 which mesh with a worm 96 fixed on the shaft 15 and thus serve to drive the mills or cutters 49, 49 through the described flexible connections.

In the operation of the machine, the mills or cutters 49, 49 are engaged with the walls of the tapered compression recesses 51, 51 at which time the parts of the machine occupy the full line positions shown in the drawings. The machine is then started, as by throwing in a clutch (not shown) interposed between the pulley 14 and the driven shaft 15. Thereafter, the shaft 15 through the driving connections therefor with the cradle 30 and the mills or cutters 49, 49, rotates said cutters and swings the cradle. During swinging movement of the cradle 30 and the cylinder head 50 thereon, swinging movement is imparted to the driven mills or cutters 49, 49, transversely of the path of swinging movement of the cylinder head 50, by the cam 78 and connections therefrom with the swiveled heads 66, 66. By these movements of the cutters and the cylinder head, the walls of the tapered compression recesses 51, 51 are machined over the entire surfaces thereof and are undercut at the deeper portions of the recesses. In the machining and undercutting operations the mills or cutters 49, 49 follow closed paths conforming with the margins of the compression recesses and identical in configuration. One of these paths is illustrated diagrammatically in Fig. 4 where A represents the traverse of the axis of the cutter, and B, C, D, E, F, and G represent, in the order named, positions successively occupied by the cutter as the latter and the work swing relatively in the manner stated. The undercutting preferably begins at the position C, ends at the position F, and is greatest at the positions D and E where are located the deeper portions of the recess that lay over the valves when the head 50 is secured on the internal combustion engine above the cylinders thereof.

It will thus appear that the machining and undercutting of the walls of the tapered compression recesses with the mills or cutters 49, 49, results from motion having two components which are circular arcs disposed in

intersecting planes that preferably extend substantially at right angle to each other. One of these components is obtained by the fore and aft swing of the cradle 30 relative to the cutters which, as illustrated diagrammatically in Figures 5 and 6, machine the walls of the tapered compression recesses in the direction of the lengths thereof. The other component is obtained by the swinging movement of the cutters which, as shown diagrammatically in Fig. 7, also machine the walls of the tapered compression recesses laterally thereof.

In some types of cylinder heads, the compression recesses thereof have reentrant portions such as indicated at H, H, (Fig. 4). In this case, the groove 35 of the cam 29 may be provided with a lobe 96 (Fig. 3) that imparts an additional motion to the cradle 30 so that the mills or cutters 49, 49 follow the margins of the reentrant portions H, H, thus insuring accurate machining of the surfaces thereof. After the machining and undercutting operations have been completed, the clutch above referred to is thrown out to stop the machine so that the parts thereof occupy the full line positions shown in the drawings. In this position of the parts, the mills or cutters 49, 49 are, as when initially engaged with the work, disposed in the shallower portions of the tapered compression recesses 51, 51. The cylinder head 50 may then be readily removed from the cradle 30 by unclamping the head 54 and swinging the strut bar 61 upwardly about its pivot 62.

It is to be expressly understood that mechanism constructed in accordance with the present invention may be employed not only for machining cylinder heads but for machining or profiling other classes of work, and that while one embodiment of the inventive idea has been illustrated and described herein with more or less detail, the invention is not limited to such embodiment, or otherwise than by the terms of the appended claims.

What is claimed is:

1. In a machine of the character described, a work holder arranged for oscillating movement and adapted to support work therein, means for oscillating the work holder and the work, a driven cutting tool extending in the work holder for engagement with the work and arranged to oscillate in the work holder about an axis extending transversely of the axis of oscillation of said work holder, and means for oscillating the driven cutting tool within the work holder during oscillating movement of the latter and the work, whereby said tool cuts into and machines said work.

2. In a machine of the character described, a driven cutting tool arranged for oscillating movement, means for oscillating the driven cutting tool, a work holder in which the driven cutting tool extends and oscillates, means supporting said work holder for oscil-

lating movement about an axis extending transversely of the axis of oscillation of the driven cutting tool, and means for oscillating the work holder during oscillating movement of the driven cutting tool therein, whereby said tool cuts into and machines work supported within the work holder and oscillating therewith.

3. In a machine of the character described, a work holder arranged for oscillating movement, means for oscillating the work holder, a tool holder arranged for oscillating movement about an axis extending transversely of the axis of oscillation of the work holder, a driven cutting tool on the tool holder extending therefrom into the work holder to oscillate therein, and means for oscillating said tool holder and the driven cutting tool during oscillating movement of the work holder, whereby said tool cuts into and machines work supported in the work holder and oscillating therewith.

4. In a machine of the character described, a tool holder arranged for oscillating movement, a driven cutting tool on the tool holder, means for oscillating the tool holder and the driven cutting tool, a work holder into which the driven cutting tool extends from the tool holder, means supporting the work holder for oscillating movement about an axis extending transversely of the axis of oscillation of the tool holder and the driven cutting tool, and means for oscillating the work holder during oscillating movement of said tool holder and the driven cutting tool, whereby said tool cuts into and machines work supported in the work holder and oscillating therewith.

5. In a machine of the character described, a cradle and a driven cutting tool extending into said cradle, both said cradle and said tool being arranged for oscillating movement each transversely of the other, a driven shaft, a flexible driving connection between the driven shaft and the driven cutting tool and providing for oscillating movement of the cutting tool in the cradle while said tool is being driven by said shaft, and means for automatically and simultaneously oscillating the cradle and the driven cutting tool, whereby said tool cuts into and profiles work engaged therewith and carried in said cradle.

6. In a machine of the character described, a work holder and a driven cutting tool therein both arranged for oscillating movement each transversely of the other, a driven shaft, a telescopic shaft, universal connections for the parts of the telescopic shaft with the driven shaft and the driven cutting tool and providing for oscillating movement of the latter in the work holder while said tool is being driven by said shaft, and means for simultaneously oscillating the work holder and the driven cutting tool therein, whereby said tool cuts into and machines work sup-

ported within said work holder and oscillating therewith.

7. In a machine of the character described, a cradle arranged for oscillating movement, a tool carrying head arranged to oscillate transversely of the path of oscillating movement of the cradle, a cutting tool rotatably mounted on the tool carrying head and extending therefrom into the cradle to rotate and oscillate therein, a driven shaft for rotating the cutting tool, a flexible driving connection between the driven shaft and the cutting tool and providing for oscillating movement thereof in the cradle while said tool is being rotated by said shaft and said connection, and means for simultaneously oscillating the cradle and the tool carrying head transversely of each other, whereby said tool cuts into and machines work supported in said cradle and oscillating therewith.

8. In a machine of the character described, an oscillating cradle, a swiveled head arranged to oscillate transversely of the path of oscillating movement of the cradle, a tool holder adjustably mounted on the swiveled head and carrying a rotatable cutting tool extending in the cradle and adapted to oscillate with said head, means for driving the cutting tool providing for oscillating movement thereof in the cradle, and means for automatically and simultaneously oscillating said elements, whereby the tool cuts into and profiles work engaged therewith and secured in the cradle.

9. In a machine of the character described, a pivoted work holder, a tool carrying head swiveled at one side to swing transversely of the direction of swinging movement of the work holder, a driven cutting tool rotatably mounted on the opposite side of the tool carrying head and adapted to engage work supported on said work holder, means for swinging the swiveled tool carrying head and the driven cutting tool, and means for swinging the work holder and the work during swinging movement of the swiveled head and the driven cutting tool, whereby said tool cuts into and machines said work.

10. In a machine of the character described, a hollow work holder trunnioned thereon, means for swinging the hollow work holder, a swiveled tool carrying head arranged to swing transversely of the path of swinging movement of the work holder and simultaneously therewith, a driven cutting tool mounted on said swiveled head to swing therewith and extending in the hollow work holder to cut into and profile work therein during said swinging movements, and means for swinging the swiveled head comprising a driven cam and a member reciprocated thereby and operatively connected with said swiveled head.

11. In a machine of the character described, an oscillating work holder, means for im-

parting oscillating motion thereto, a plurality of driven cutting tools arranged to oscillate transversely of the path of oscillating movement of the work holder and extending within the latter, and means for simultaneously oscillating said tools in the work holder during oscillating movement of said work holder, whereby the tools cut into and profile work engaged therewith and carried in the work holder.

12. In a machine of the character described, an oscillating work holder, means for imparting oscillating motion thereto, a plurality of tool carrying heads arranged to oscillate transversely of the path of oscillating movement of the work holder, a driven cutting tool on each of said heads extending therefrom into the work holder and adapted to cut into and profile work supported therein during oscillating movement of the work holder, means for driving the tools providing for oscillating movement of the same with the tool carrying heads and within the work holder, and means for simultaneously oscillating said heads and the driven tools carried thereby.

13. In a machine of the character described, a pivotally mounted work holder, means for imparting swinging motion thereto, a plurality of tool carrying heads arranged to swing transversely of the path of swinging movement of the work holder, a cutting tool rotatably mounted on each of said heads and extending therefrom into the work holder to swing therein and engage work supported within the same, a driven shaft, flexible driving connections for said shaft with the tools adapted to rotate the same and providing for swinging movement of said tools with the swinging heads and within the work holder, and means for simultaneously swinging the tool carrying heads during swinging movement of the work holder whereby several portions of the work carried in the latter in engagement with the driven tools are simultaneously cut or machined and profiled thereby.

14. In a machine of the character described, an oscillating work holder adapted to support a cylinder head therein having tapered compression recesses, means for swinging the work holder and said cylinder head, a plurality of driven mills or cutters arranged to swing transversely of the path of swinging movement of the cylinder head and extending within the work holder to engage the walls of the compression recesses, and means for simultaneously swinging the driven mills or cutters in the work holder during swinging movement of the latter and the cylinder head, whereby said mills or cutters cut or machine the walls of the compression recesses and undercut said walls at the deeper portions of the recesses.

15. In a machine of the character described,

an oscillating work holder adapted to support a cylinder head therein having tapered compression recesses, means for swinging the work holder and said cylinder head, a plurality of devices swiveled on the machine to swing transversely of the path of swinging movement of the work holder and the cylinder head, a corresponding number of driven mills or cutters carried by said swiveled devices and extending therefrom into the work holder to swing therein and engage the walls of the tapered compression recesses, and means for simultaneously swinging said swiveled devices during swinging movement of the work holder and the cylinder head, whereby said mills or cutters cut or machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

16. In a machine of the character described, a work holder trunnioned thereon adapted to support a cylinder head having tapered compression recesses therein, means for swinging the work holder and said cylinder head, a plurality of driven mills or cutters arranged to swing transversely of the path of swinging movement of the cylinder head and engage the walls of the tapered compression recesses, a driven shaft, a plurality of telescoping shafts, universal connections for the parts of each telescoping shaft with the driven shaft and one of said mills or cutters, and means for simultaneously swinging the driven mills or cutters during swinging movement of the cylinder head, whereby the mills or cutters machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

17. In a machine of the character described, a work holder trunnioned thereon adapted to support a cylinder head having tapered compression recesses therein, means for swinging the work holder and said cylinder head, a plurality of devices swiveled on the machine to swing transversely of the path of swinging movement of the work holder and the cylinder head, a plurality of driven mills or cutters each mounted on one of said swiveled devices and adapted to engage the wall of one of the tapered compression recesses, a reciprocating element connected with each of the swiveled devices for simultaneously swinging them to rock the driven mills or cutters in the tapered compression recesses, and a cam for reciprocating said element during swinging movement of the work holder and cylinder head, whereby the mills or cutters machine the walls of the compression recesses and undercut said walls at the deeper portions of the recesses.

18. In a machine of the character described, a work holder for supporting a cylinder head having compression recesses therein of tapered depth, means supporting said work holder for swinging movement rearwardly

and forwardly of the machine, means for swinging the work holder and the cylinder head thereon, a plurality of driven mills or cutters arranged to engage the walls of the tapered compression recesses and mounted to swing toward opposite sides of the machine across the path of swinging movement of the work holder and the cylinder head, and means for swinging the driven mills or cutters simultaneously during swinging movement of the work holder and cylinder head, whereby said mills or cutters simultaneously machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

19. In a machine of the character described, a cradle arranged at the front thereof to support a cylinder head having compression recesses therein of tapered depth, bearings for said cradle providing for swinging movement of the same rearwardly and forwardly of the machine, means for swinging the cradle with the cylinder head secured thereon, a plurality of driven mills or cutters adapted to engage the walls of the tapered compression recesses and arranged in line across the front of the machine for swinging movement laterally of the path of swinging movement of the cradle and the cylinder head, and means for swinging the driven mills or cutters simultaneously during swinging movement of the cradle and cylinder head, whereby said mills or cutters machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

20. In a machine of the character described, a column or the like having an overhanging head, a cradle trunnioned on said head for swinging movement and adapted to support a cylinder head having compression recesses therein of tapered depth, means for swinging the cradle and the cylinder head thereon, a plurality of driven mills or cutters adapted to engage the walls of said recesses and mounted on the head of said column for swinging movement laterally of the path of swinging movement of the cradle and the cylinder head, and means for swinging the driven mills or cutters simultaneously during swinging movement of the cradle and cylinder head, whereby said mills or cutters machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

21. In a machine of the character described, a work holder for supporting a cylinder head having compression recesses therein of tapered depth, means supporting said work holder for swinging movement rearwardly and forwardly of the machine, a plurality of tool-carrying heads mounted on said means to swing toward opposite sides of the machine laterally of the path of swinging movement of the work holder and the cylinder head, a driven mill or cutter mounted

on each of said tool-carrying heads to swing therewith and adapted to engage the wall of one of the tapered compression recesses, and means for swinging the tool-carrying heads simultaneously during swinging movement of the work holder and cylinder head, whereby the driven mills or cutters machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

22. In a machine of the character described, a work holder for supporting a cylinder head having compression recesses therein of tapered depth, means supporting said work holder for swinging movement rearwardly and forwardly of the machine, means for swinging the work holder and the cylinder head thereon, a plurality of tool-carrying heads swiveled on said first named means to swing toward opposite sides of the machine laterally of the path of swinging movement of the work holder and the cylinder head, a tool holder mounted on each swiveled head to swing therewith and adjustable lengthwise of said swiveled head, a driven mill or cutter rotatably mounted on each tool holder and adapted to engage the wall of one of the tapered compression recesses, and means for swinging the swiveled heads simultaneously during swinging movement of the work holder and cylinder head, whereby the driven mills or cutters machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

23. In a machine of the character described, a column or the like having an overhanging head projecting therefrom, a cradle mounted on said head to depend therefrom and swing toward and away from the column, a driven tool mounted on the overhanging head to extend downwardly therefrom into the cradle and swing transversely of the path of swinging movement of the latter and means for swinging the cradle and the driven tool therein simultaneously, whereby said tool profiles work engaged therewith and carried in the cradle.

24. In a machine of the character described, a column or the like having an overhanging head projecting therefrom, a cradle mounted on said head to depend therefrom and swing toward and away from the column, a tool carrier swiveled on the overhanging head to swing transversely of the path of swinging movement of the cradle, a driven tool mounted on said tool carrier and extending downwardly into the cradle, and means for swinging the cradle and the swiveled tool-carrying head simultaneously, whereby the driven tool profiles work engaged therewith and carried in the swinging cradle.

25. In a machine of the character described, a column or the like having an over-

hanging head projecting therefrom, a cradle mounted on said head to swing thereunder toward and away from the column, a driven tool extending in the cradle and pivoted thereabove on the overhanging head to swing in the cradle transversely of the path of swinging movement of the latter, and means for swinging the cradle and the driven tool therein simultaneously, whereby said tool profiles work engaged therewith and carried in the swinging cradle.

26. In a machine of the character described, a column or the like having an overhanging head projecting therefrom, a cradle depending from said head and trunnioned thereon to swing toward and away from the column, a tool carrier extending in the cradle and swiveled thereabove on the front of said overhanging head to swing transversely of the path of swinging movement of said cradle, a driven tool mounted on the swiveled tool carrier to swing therewith in the cradle and engage work carried therein, and means for swinging the cradle and the tool carrier simultaneously, whereby the driven tool profiles said work.

27. In a machine of the character described, a column or the like having an overhanging head, a work holder mounted on said head to swing forwardly and rearwardly of the machine, a plurality of driven tools mounted above the work holder and swiveled on the overhanging head to swing transversely of the path of swinging movement of the work holder, means for swinging the work holder, and means for swinging the driven tools simultaneously during swinging movement of the work holder, whereby said tools profile work engaged therewith and carried on the work holder.

28. In a machine of the character described, a column or the like having an overhanging head, a work holder mounted on said head to swing thereunder rearwardly and forwardly of the machine, a plurality of tool carriers mounted above the work holder and swiveled on the front of the overhanging head to swing transversely of the path of swinging movement of the work holder, a driven tool mounted on each of said tool carriers to swing therewith, means for swinging the work holder, and means for swinging the swiveled tool carriers simultaneously during swinging movement of the work holder, whereby the driven tools profile work engaged therewith and carried on the work holder.

29. In a machine of the character described, a column or the like having an overhanging head, a saddle at the top of said head, a driven shaft journaled on said saddle, a tool swiveled on the front of the overhanging head to swing toward opposite sides of the machine, a flexible driving connection for the tool with said driven shaft, a

work holder mounted on the overhanging head to swing thereunder transversely of the path of swinging movement of the driven tool, and means for swinging said tool and the work holder simultaneously, whereby the tool profiles work engaged therewith and carried on the swinging work holder.

30. In a machine of the character described, a column or the like having an overhanging head, a driven shaft journaled on said head, a plurality of tools swiveled on the front of the overhanging head to swing toward opposite sides of the machine, flexible driving connections for the swinging tools with said driven shaft, a work holder mounted on the overhanging head to swing transversely of the path of swinging movement of the driven tools, and means for swinging the work holder and the driven tools simultaneously, whereby said tools profile work engaged therewith and carried on the swinging work holder.

31. In a machine of the character described, a column or the like having an overhanging head, a driven shaft journaled on said head, a plurality of tool carriers arranged in alignment across the front of the overhanging head and swiveled thereon to swing toward opposite sides of the machine, a tool rotatably mounted on each of said tool carriers and flexibly connected with the driven shaft to provide for swinging movement of said carriers and the driven tools thereon, a cradle trunnioned on the overhanging head to swing below the driven tools forwardly and rearwardly of the machine, and means for swinging the tool carriers and the cradle simultaneously, whereby the tools profile work engaged therewith and carried on the cradle.

32. In a machine of the character described, a column or the like having an overhanging head extending forwardly thereof from, a driven shaft journaled on said head, a plurality of mills or cutters arranged in line across the front of the overhanging head and swiveled thereon to swing toward opposite sides of the machine, means for driving the mills or cutters including the driven shaft and flexible connections therefor with said mills or cutters, a work holder adapted to support a cylinder head with compression recesses therein of tapered depth, means supporting said work holder on the overhanging head for swinging movement transversely of the path of swinging movement of the mills or cutters, means for simultaneously swinging the mills or cutters in engagement with the walls of the tapered compression recesses, and means for swinging the work holder and the cylinder head during swinging movement of the mills or cutters, whereby the walls of the tapered compression recesses are machined and undercut at the deeper portions of the recesses.

33. In a machine of the character described, a column or the like having an overhanging head, a driven shaft journaled on said head, a plurality of tool carriers arranged in line across the front of the overhanging head and swiveled thereon to swing toward opposite sides of the machine, a mill or cutter rotatably mounted on each of the swiveled tool carriers to swing therewith, a flexible driving connection between each mill or cutter and the driven shaft, a work holder adapted to support a cylinder head having compression recesses therein of tapered depth, means supporting said work holder on the overhanging head for swinging movement transversely of the path of swinging movement of the mills or cutters, means for swinging the tool carriers simultaneously while the mills or cutters are engaged with the walls of the tapered compression recesses, and means for swinging the work holder and the cylinder head during swinging movement of the tool carriers, whereby the swinging mills or cutters machine the walls of the tapered compression recesses and undercut said walls at the deeper portions of the recesses.

34. In a machine of the character described, a column or the like having an overhanging head, a driven shaft journaled on said head, a plurality of mills or cutters arranged in line across the front of the overhanging head and swiveled thereon to swing toward opposite sides of the machine, means for swinging the swiveled mills or cutters simultaneously comprising an element connected therewith and a cam for reciprocating said element, a work holder mounted on the overhanging head for swinging movement transversely of the path of swinging movement of the swiveled mills or cutters and adapted to support and swing a cylinder head having compression recesses therein of tapered depth, and means for swinging the work holder and cylinder head while the swinging mills or cutters engage the walls of the tapered compression recesses, whereby said walls are machined and undercut at the deeper portions of the recesses.

35. In a machine of the character described, a column or the like having an overhanging head, a driven shaft journaled thereon, a plurality of mills or cutters arranged in line across the front of the overhanging head and swivelled thereon to swing toward opposite sides of the machine, means for driving the mills or cutters including the driven shaft and flexible connections therefor with each of said mills or cutters, means for swinging the driven mills or cutters including a reciprocating element connected therewith, a cam rotatably mounted on the overhanging head, and driving connections for the cam with said reciprocating element, a work holder mounted on the overhanging

head to swing transversely of the path of swinging movement of the mills or cutters and adapted to support a cylinder head having compression recesses therein of tapered depth, and means for swinging the work holder and the cylinder head while the swinging mills or cutters engage the walls of the tapered compression recesses, whereby said walls are machined and undercut at the deeper portions of the recesses.

36. In a machine of the class described, the combination of a support having a forwardly projecting overhanging head, a cradle trunnioned on said head to swing toward and from said support and beneath said head, a plurality of tools mounted on said head to swing in a plane passing through the trunnions of said cradle and automatic means simultaneously swinging said cradle and tools.

37. In a machine of the class described, the combination of a support having a forwardly projecting overhanging head, a cradle trunnioned on said head to swing toward and from said support and beneath said head, a plurality of tools mounted on said head to swing in a plane passing through the trunnions of said cradle, a driven shaft on said head, flexible driving connections between said shaft and each of said tools, and automatic means simultaneously swinging said cradle and tools.

38. In a machine of the character described, a support, a cradle provided at opposite extremities thereof with trunnions journaled on the support, a driven cutting tool mounted on said support to oscillate on an axis extending substantially at right angles to a line passing through said trunnions, said cutting tool extending from the support into the cradle and intersecting said line, and means for oscillating the cradle and the driven cutting tool, whereby said tool cuts into and machines work supported in the cradle to oscillate therewith.

39. In a machine of the character described, a support, a cradle provided at opposite extremities thereof with trunnions journaled on the support, means for oscillating the cradle, a tool holder mounted on said support to oscillate on an axis extending substantially at right angles to a line passing through said trunnions, a driven cutting tool mounted on the tool holder to oscillate in the cradle and having a longitudinal axis intersecting said line, and means for oscillating said tool holder and the driven cutting tool during oscillating movement of the cradle, whereby said tool cuts into and machines work supported in the cradle and oscillating therewith.

In testimony whereof I have signed this specification.

JOHN M. CHRISTMAN.